BOOK REVIEWS

GROUNDWATER AS A GEOMORPHIC AGENT; R. G. LaFleur (Editor), 1984. The 'Binghamton' Symposia on Geomorphology: International Series, No. 13, Allen & Unwin, Boston, 390 p. (£30.00).

This volume is a collection of essays based on papers presented at the 13th Geomorphology Symposium of the Binghamton series. The title *Groundwater as a Geomorphic Agent* is a reasonable guide to the content, but three chapters are completely out of place: 'Rates of soil formation' and 'Landforms and soils of the Tropics', both by Foss and Segovia, and 'Potential effects of acid rain on glaciated terrain' by Shilts. Of the remaining twelve chapters, nine are on karst. They include a range of topics covering hydrological classification of karst features, models of carbonate solution, simulation of karstic aquifers, role of groundwater in shaping a carbonate coastline, karst groundwater in a permafrost region, and hydrogeomorphic evolution of karst landforms. The authorship and examples are strongly biased towards North America, but the general significance of much of the material is considerable.

White's chapter on 'Rate processes: chemical kinetics and karst landform development' is an elaboration of a theme on which he has published previously, but it provides an up-to-date and mature overview of the chemical literature particularly useful for its consideration of dolomite. Drake presents a provocative 'pot boiler', entitled 'Theory and model for global carbonate solution by groundwater', while Palmer's essay is a characteristically excellent blend of meticulous field observation and theory. He relates, quantitatively, chemical and hydrological processes to the rate of enlargement of groundwater conduits and then proceeds to illustrate its application to karsts in Bermuda, Kentucky and Indiana.

Two chapters stand out because of the valuable contributions they make to neglected topics. The first by Back and others examines the role of groundwater in shaping a carbonate coastline, and convincingly concludes that landforms previously attributed to paleokarst developed at lower sea levels must often be ascribed to contemporary corrosion in the mixing zone of fresh and salt waters. The second by Ford investigates the almost unknown territory of karst groundwater activity in permafrost zones, in this case in Canada. He addresses two problems: (1) the extent of modern karst groundwater circulation and associated landforms in present permafrost terrains, and (2) an evaluation of whether karst circulations may develop beneath glaciers in regions that will become permafrost upon deglaciation. He concludes, firstly, that where permafrost today is not continuous there is unimpeded karstic circulation and expansion, but with conduit networks probably inherited from previous conditions; and, secondly, that sub-glacially generated karst systems can develop but cannot be passed on as a viable inheritance should continuous permafrost be established upon deglaciation.

Chapters on 'Theoretical considerations on simulation of karstic aquifers', 'Karst landform development along the Cumberland Plateau escarpment of Tennessee' and 'Hydrogeomorphic evolution of karsted plateaus in response to regional tectonism' usefully complement the contributions on karst.

By far the most useful of the non-karst essays is that by Twidale, entitled the 'Role of subterranean water in landform development in tropical and subtropical regions'. It is a scholarly review, with much evidence of excellent personal observation, largely drawing on arid zone Australian examples. The interpretation of groundwater to include soil and regolith moisture is essential in the context of this essay (I can never, in any case, accept the logic of most groundwater texts in confining attention largely to the phreatic zone), which deals with the development of weathering fronts, etch surfaces, and duricrusts. We can hardly argue with his conclusion that "If nature were like a connoisseur of Scotch and had no water, the world would be a very different place . . . the geomorphological world would scarcely be recognizable."

A very difficult to interpret geomorphological world is, in fact, part of the subject of Higgins' essay on 'Piping and sapping: development of landforms by groundwater outflow'. His leap from rill production on sandy beaches in California to an explanation, by analogy, of drainage systems on Mars is demanding on the reader, not least because of the vast difference in scale. The chapter is nonetheless interesting and well illustrated.

The book is clearly a hotchpotch in terms of topic, treatment, style and depth, loosely structured round the theme and uneven in coverage. I would have preferred to see the papers published in regular journals or, alternatively, for the book to have been carefully planned with invited complementary essays in logical sequence. Nevertheless, there are several very valuable contributions that are important stepping stones in the development of our understanding. This is an essential volume for an earth science reference library.

Paul W. Williams

CHANGING CLIMATE, by the Carbon Dioxide Assessment Committee, U.S. National Research Council (1983). National Academy Press, Washington, D.C., 496 p. (U.S. $29.50).

CAN WE DELAY A GREENHOUSE WARMING? by Stephen Seidel and Dale Keyes (1983). U.S. Environmental Protection Agency, Washington, D.C., 192 p. (U.S. $6.00).

These two reports from important American governmental agencies present the latest thinking of the science establishment of that country relative to the so-called greenhouse effect of carbon dioxide (CO_2). In a posture unchanged for the past decade or so, the reports predict that the mean near-surface air temperature of the globe will increase by 3 $\pm$ 1.5°C for a 300 to 600 part per million doubling of the atmospheric CO_2 concentration — something which the report of the National Research Council (NRC) suggests is most likely to happen by the year 2065. The warming is not expected to be uniform, however, but to be several times greater than the global mean in the vicinity of the poles. As a result, both reports foresee the melting of vast quantities of snow and ice, which they claim will lead to an increase in sea level and the flooding of coastal lowlands.

Of particular interest to hydrologists is the ancillary prediction of the NRC report that there will be about a 10% reduction in rainfall in the key food-producing regions of middle latitudes. Together with the expected increase in air temperature, this drop in precipitation is projected to lead to decreases in streamflow ranging from 40 to 75%. Thus, the report of the Environmental Protection Agency (EPA) concludes that "agricultural conditions will be significantly altered, environmental and economic systems potentially disrupted, and political institutions stressed." Furthermore, in an analysis of several different energy policy options designed to forestall the CO_2 greenhouse effect, they conclude that there is essentially nothing we can do to avoid these calamities.

Both reports thus present a very bleak view of the future, so bleak, in fact, that one's credulity is severely strained in attempting to swallow the whole prognostication package which they have prepared. Indeed, when it is looked at in detail, several chinks in the armor of their doomsday scenario begin to undermine its credibility.

For one thing, the real world does not appear to be behaving in the way that the climate models used by the NRC and EPA predict it should. From information in the NRC report, for example, it can be calculated that between 1880 and 1980 there should have been a 3°C warming of the northern third of the globe brought about by the rising CO_2 content of the atmosphere, according to the models. Yet the actual temperature history of this region, also in the NRC report, depicts a net warming over the period of only 0.3°C. And for the last half of this time span the temperature trend of the northern third of the globe has been *downward* at more than 0.1°C per decade (*J. Environ. Qual.*, vol. 12, p. 159) — strange behavior for the region of the Earth which is supposed to exhibit a warming tendency several times greater than anywhere else.

How is it, that in the region of the world most favorable to vindicating their predictions, the models fail so miserably? As I have suggested in my own book on this topic — CARBON DIOXIDE: FRIEND OR FOE? (IBR Press, 631 E. Laguna Dr., Tempe, AZ 85282, USA) — it is quite likely that the models are omitting or improperly treating some important real-world processes. And, in fact, the creators of the models readily admit to this fact, as I demonstrate in my book.

As an example of the seriousness of this model deficiency, consider the NRC report's prediction of 40 to 75% reductions in streamflow for a CO_2 concentration doubling. This projection was based on the assumption that evapotranspiration is controlled "solely by temperature". In reality, however, the tendency for atmospheric CO_2 enrichment to induce partial stomatal closure and thereby curtail the magnitude of plant evaporative water loss is even more important; and when A. R. Aston of Australia recently included this effect in a more realistic model of watershed runoff (*J. Hydrol.*, vol. 67, p. 273), he found that "we can expect streamflow to *increase* from 40 to 90% as a consequence of doubling the atmospheric CO_2 concentration".

Indeed the biological benefits of atmospheric CO_2 enrichment appear to be much more significant and founded upon solid experimental research than do the climatic speculations of the NRC and EPA. For instance, B. A. Kimball recently reviewed the literature relative to CO_2 effects on plant growth and development (*Agron. J.*, vol. 75, p. 779), deducing from an analysis of several hundred prior experimental observations that world-wide agricultural productivity "probably will increase by 33% with a doubling of atmospheric CO_2 concentration". And a similar review of the antitranspirant properties of CO_2 (*Agric. Water Manage.*, vol. 7, p. 55) led to the conclusion that "a doubling of CO_2 concentration could reduce transpiration by 34%".

These documented research results thus indicate that a simple doubling of the atmospheric CO_2 content will lead to an actual doubling of plant water use efficiency, or the yield produced per unit of water used. What is more, recent research by U.S. Department of Agriculture scientists indicates that a quadrupling of the atmospheric CO_2 content will probably lead to a four-fold increase in plant water use efficiency — for both agronomic and forest species (*Science*, vol. 220, p. 428).

In view of these proven biological benefits, and the essentially speculative basis of the adverse climatic predictions of the NRC and EPA, I can only conclude at this point in time that atmospheric CO_2 enrichment is a thing to be desired. The contrary views of the NRC and EPA may thus prove counterproductive to our future well-being if they begin to influence governmental decision-makers. Everyone must therefore be introduced to the full spectrum of scientific thinking on this important topic.

Sherwood B. Idso

MECHANICS OF FLUIDS 5th Edition by B. S. Massey. Van Nostrand Reinhold Co. Ltd., Wokingham, England, 625p (£7.25).

This textbook has been widely used in undergraduate civil and mechanical engineering courses for a number of years, and its qualities of clear explanation of phenomena, sufficient rigour to make analyses satisfying and a wide selection of examples have made it one of the most respected texts in its field. This fifth edition retains these qualities, and significant revisions have been made, such as adding a brief treatment of dimensional analysis and some discussion of particle mechanics in the context of fluid drag.

The purpose of this review, is less to reassert the excellence of this book for engineers than to recommend it as a valuable reference book for non-engineers whose interests demand some level of understanding of fluid mechanics. Geomorphologists and other earth scientists (particularly those concerned with fluvial and coastal processes), hydrologists, meteorologists, soil conservators and other non-engineering Catchment Board staff, would all find in Massey's text clear and reasonably simple explanations of the phenomena with which they work; where (as is often the case) no simple explanation yet exists, the reader is pointed in the (presently) right direction. The mathematics required to follow text is modest, a sound grasp of calculus being sufficient. Some sections (that on compressible flow, for example) will be of little interest to most readers of this Journal, but the majority of the content of this modestly-priced paperback is of direct relevance. (Even the section on hydraulic machinery has a useful outline of cavitation which, had it been available, would have shed light on the writer's part in a heated discussion on the formation of ripple marks in limestone which took place several hundred feet underground at Punakaiki last year!).

My only reservation about unreservedly recommending this book is due to its rather restricted treatment of open channel flow phenomena. The widely-used book "Open Channel Flow" by F. M. Henderson would certainly be a valuable supplementary source for those concerned primarily with flows having a free surface, but even here Massey has much to contribute by way of fundamental underpinning to the more specialised work, including a thorough discussion of the properties of fluids with one of the best available explanations of viscosity.

By today's standards this book is very reasonably priced, although it is insufficiently robust for field use. Earth and water scientists of many specialisations would find it an invaluable addition to their resources.

T.R.H. Davies

FORTHCOMING EVENTS

11 March-14 June 1985: Graduate Course in Hydrology, University of New South Wales, School of Civil Engineering. Students can elect to specialise in either surface water or ground water hydrology. Suitable for engineers, surveyors, agricultural scientists, meteorologists, foresters, soil conservators and hydroleologists. Basic cost $A1,350. Further details from Professional Education Office, School of Civil Engineering, P.O. Box 1, Kensington N.S.W. 2033.

June 3-7 1985: International Symposium on the Stochastic Approach to Subsurface Flow. Paris School of Mines, Fontainbleau, France. Contact: G. de Marsily, Greco-Hydrogéologie, Ecole de Mines de Paris, Centre d'Information Géologique, 35 rue Saint-Honoré, 77305 Fontainbleau-Cédex, France.

June 7-19 1985: International Symposium on Karst Water Resources, Ankara and Antalya, Turkey. Contact: A. Ivan Johnson, Woodward-Clyde Consultants, 7600 East Orchard Rd, Harlequin Plaza North, Englewood, Colorado 80111, U.S.A.

August 18-24 1985: International Workshop on Hydrologic Applications of Space Technology. Cocoa Beach, Florida, U.S.A. Contact: A. Ivan Johnson, President, I.A.H.S. International Committee on Remote Sensing and Data Transmission, 7474 Upham Court, Arvada, Colorado 80003, U.S.A.

September 19-23 1985: International Symposium on Scientific Basis for Water Resources Management. Jerusalem, Israel. I.A.H.S./Israel Association of Hydrology. Contact: KENES, P.O. Box 5006, Tel Aviv 61500, Israel.

October 7-10 1985: Workshop on Statistical Aspects of Water Quality Monitoring, C.C.I.W., Burlington, Ontario, Canada. Contact: A El-Shaarawi, Aquatic Physics and Systems Division, NWRI, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario L7R 4A6, Canada.